Floating marshes and forest wetlands *comprise the complex estuarine resource of the Barataria Preserve unit of Jean Lafitte National Historical Park, site of recent 3-D seismic oil exploration activities. To reduce compaction of marsh vegetation, reduced-weight, aluminum marsh buggies were used to drill and set explosives.*

RESOURCE DISTURBANCES

The natural resources held in trust by the National Park Service are remarkably diverse and awe-inspiring. However, maintaining them in an unimpaired condition is a daily struggle for professional resource managers. Both external and internal influences disrupt the very resources that inspire public pride. Nonnative species, environmental contamination, noise pollution, and even legitimate park uses caused great concern and required remedial action in 1998. To be effective resource stewards, managers must first recognize a decline in resource condition before they can begin to understand its causes and work out suitable remedies. Even then, finding solutions can be complex, time-consuming, and expensive. Science tools such as inventories, monitoring, and research provide direction and suggest many courses of action. However, for the National Park Service to be most effective in preserving natural resources, it must elevate science to a level commensurate with the demands of the widespread and often confounding natural resource disturbances confronted in parks today.

Oil & Gas Development

JEAN LAFITTE LEARNS FROM 3-D SEISMIC OIL EXPLORATION EXPERIENCE

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Petroleum exploration technology advanced into the national parks in 1998 when a three-dimensional seismic operation was undertaken in Jean Lafitte National Historical Park and Preserve (Louisiana), the first such operation in a national park. This new technology presented challenges for park managers to protect resources while providing for the exercise of nonfederal oil and gas rights consistent with the park's enabling legislation. Cooperative planning with the operator, Burlington Resources, was crucial to reducing the resource impacts of this intensive operation.

As a geophysical exploration technique, 3-D seismic technology is a relatively new application of an old skill: listening. Energy waves are generated near the earth's surface by detonation of an explosive charge known as a source. The energy travels through the earth to a subsurface target, where it is reflected back to the surface to be recorded on a grid of receivers. The recorded energy waves are then computer-analyzed to identify potential petroleum reserves. It is the grid of sources and receivers that makes 3-D different from the 2-D or straight-line operations of the past.

The Burlington Resources operation covered 32,000 acres, including 6,360 acres of the park's Barataria Preserve unit, a highly productive estuarine complex of floating marshes and forest wetlands. Within the park, 477 sources were detonated on precise alignments along 36 miles of source lines. The generated energy was then recorded by 1,300 receivers along 54 miles of receiver lines laid out in an overlapping grid.

During 18 months of planning, a number of creative solutions were developed to protect sensitive resources such as rare plant communities, popular hiking and canoe trails, archeological sites, and long-term research plots. Bio-remediating explosives were used to avoid water and soil contamination. Travel routes were carefully designed and equipment was modified to reduce weight to minimize compression of the organic marsh substrate and resulting hydrologic modifications. Very sensitive resources were designated as avoidance areas for all motorized equipment. Park newsletter and local newspaper articles kept the community informed, and a new interpretive wayside paid for by the operator explained this complex operation to park visitors.

Essential to successful implementation of the planned operation was the use of third-party compliance monitors hired by the operator with approval by the park. Monitoring was accomplished by wetland scientists, who provided on-site control of all field operations under the

VEGETATION MAPPING

Vegetation-mapping products from the USGS Biological Resources Division–funded and –administered program for vegetation mapping on NPS lands increased in 1998. However, at the current funding level, the program would take 30 years or more to fill all park vegetation-mapping needs. Plans for 1999 are to realize efficiencies in the overlap of vegetation-mapping products for NPS fire management under the FirePro program (i.e., development of park-specific fire fuels maps and plots for fire effects monitoring) and those intended for general resource management use. The resulting products will serve both purposes.

Jean Lafitte National Historical Park

Jean Lafitte National Historical Park

Organic matting *was employed on exposed substrates to stabilize soils until plants from the surrounding marsh could recolonize damaged sites.*

guidance of the park's natural resource management specialist. The monitors maintained daily contact with the many field crews and provided comprehensive documentation of field activities during 74 days of continuous operations.

Thanks to cooperative planning and effective monitoring, resource damage was minor and localized. In the few areas where damage occurred, the substrate was stabilized with organic matting and, where needed, replanted. Most plant communities had recovered by the end of the growing season. Aerial photography and visual inspections will continue for three years, as planned, but no long-term impacts are anticipated.

To share insights regarding 3-D seismic operations, Jean Lafitte hosted a workshop in May for other parks with nonfederal oil and gas rights. As 1998 drew to a close, Big Thicket National Preserve (Texas), Big Cypress National Preserve (Florida), and Padre Island National Seashore (Texas) were all in the planning or implementation process for other 3-D seismic operations, and more are likely to follow.

EXOTIC INSECT JEOPARDIZES EASTERN HEMLOCKS

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First detected in Shenandoah National Park (Virginia) 10 years ago, the hemlock woolly adelgid is an aphidlike insect that sucks sap from branchlets of eastern hemlock. The tree loses strength and sheds its needles, which can lead to death unless conditions are ideal for survival. Though isolated trees may avoid the threat posed by this nonnative insect infestation, hemlock stands may not survive beyond 5–10 years. This has grave implications for associated species.

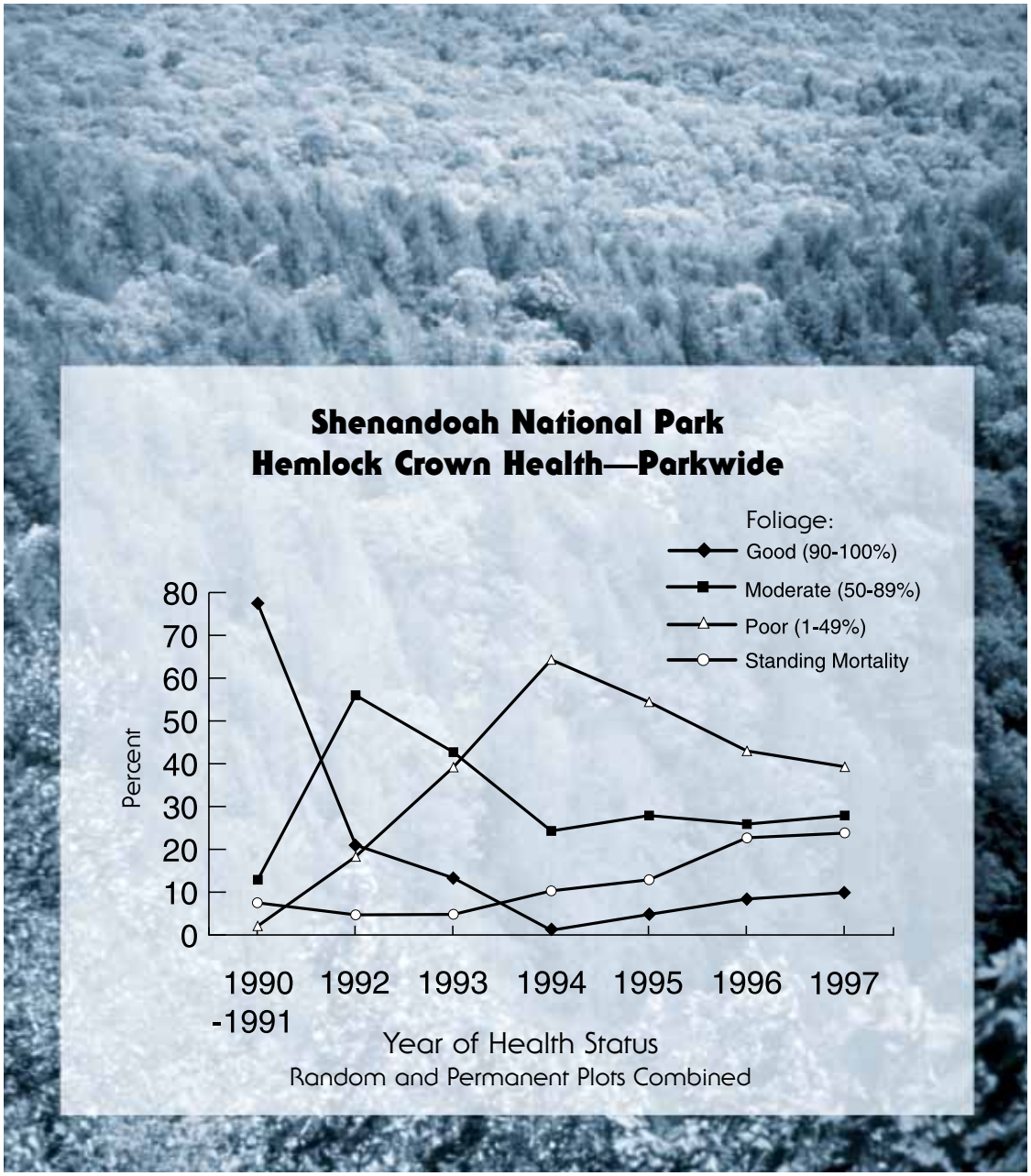
Fading tree-crown color, from robust deep greens to grayish tones, led to the discovery of the infestation in Thornton and Frazier Hollows, and by 1993 the insect was found in hemlocks throughout the park. Since 1991, formerly full-crowned trees (77% of the population) have been reduced to thin, partial crowns with much associated mortality. Interestingly, this negative trend slowed down during 1996–98, which led the park and researchers from the USGS Biological Resources Division to surmise that the harsh winter of 1995–96 contributed to adelgid decline. However, two recent, mild winters and a drought in 1998 may cause further hemlock decline, given that moisture stress hinders the hemlock's ability to resist effects of the insect.

The park and the Biological Resources Division are working together to ferret out the risk factors associated with the infestation and to create a model that predicts associated mortality. Using Geographic Information Systems and statistical analyses of the park's annual hemlock crown assessment data, the team found areas of higher risk potential. Heavier impacts seem to occur at lower elevations, probably indicating the importance of winter cold in controlling the insect. They also found that slope, light conditions (such as site aspect and position), and distance to streams correlated with hemlock condition. The results of this preliminary analysis are helping to guide 1999 research, which will look at several years of imagery and weather and climate data to correlate and model

hemlock stand vulnerability as a result of site, landscape, and regional factors.

While research is aimed at understanding factors contributing to the infestation and decline, resource management activities seek to protect the tree species. Shenandoah has adopted the following objectives: (1) preserving a seed source for future hemlock reestablishment, (2) preserving individuals in important cultural sites and recreation areas, and (3) reducing the risk of falling trees in highly visited areas. In FY 1998, recognizing the dire situation of the hemlock forest, resource managers increased the frequency and breadth of their efforts to suppress the hemlock woolly adelgid. Nevertheless, treatments are still limited to areas accessible by vehicles equipped with hydraulic spray equipment, which are used to apply insecticidal soap or horticultural oil. This approach is employed by other federal agencies too. High-value individual hemlocks located far from roads may be treated with systemic insecticides on a case-by-case basis.

With such limited treatments, the long-term hope for the eastern hemlock in Virginia may be the introduction of natural, albeit nonnative, biological controls. The U.S. Forest Service and the Connecticut Agricultural Experiment Station are carefully testing several Asian insects on the East Coast with such a purpose in mind.



Graph—Shenandoah National Park; James Akerson; Photo—Shenandoah National Park

ZEBRA MUSSELS AT ST. CROIX

Following another year of active monitoring, education, access management, and research, the St. Croix National Scenic Riverway (Wisconsin and Minnesota) is still considered free of reproducing populations of the exotic freshwater zebra mussel, which threatens native mussels. During the year there was no duplication of the 1997 finding of nearly 50 juvenile zebra mussels on a plate sampler, although the species was again discovered on boats and sporadically on native mussels and other hard substrates.

Shenandoah National Park

The presence of white, woolly masses *on hemlock branchlets is a sure sign of hemlock woolly adelgid, the nonnative insect species responsible for the alarming decline in hemlock health in Shenandoah. Larvae are the size of aphids and produce cottonlike tufts that stay with the species throughout its life.*

Although small, *a patch of yellow toadflax in an otherwise pristine-looking meadow in Rocky Mountain National Park is symbolic of the far-reaching threat of invasive plant species. The park has begun to focus on assessing, controlling, and monitoring 12 problem exotics with the help of park neighbors and innovative funding programs.*

Both Rocky Mountain *National Park and Weir Farm National Historic Site raised awareness of invasive plant problems in and around their parks during 1998 by forming weed-control teams funded partly by the Pulling Together Initiative. As one of its activities, the Rocky Mountain team pulled nonnative dalmation toadflax from an upland shrub and grassland meadow.*

PARKS CULTIVATE PARTNERSHIPS TO TACKLE NOXIOUS WEEDS

GPRA

by Jeff Connor and Greg Waters

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Invasive nonnative plants are the most serious threat to native plants, and the spread of some noxious weeds poses tremendous economic damage to public and private lands. Control of nonnative plants, however, is doomed unless adjacent landowners unite in their efforts. Such unions by parks and local communities in Colorado and in Connecticut have been highly successful.

Rocky Mountain National Park and its gateway community of Estes Park teamed up in 1998 to assess, control, and monitor 12 problem plants. The partnership came about because the town feared the spread of leafy spurge from inside to outside the park, and the park wanted to prevent the spread of diffuse knapweed to inside its boundaries. Ultimately, the park and Estes Park became one of six demonstration sites in Colorado where public and private entities are working together.

Monies supporting the partnership came from several sources, primarily the National Fish and Wildlife Foundation's Pulling Together Initiative and a matching grant from the Colorado Noxious Weed Management Fund. Additionally, NPS Fee Demonstration Program project funds and Larimer County Parks and Open Space provided grants to combat leafy spurge, diffuse knapweed, and 10 other noxious weeds. The park, home owners' associations and private landowners, the U.S. Forest Service, Bureau of Reclamation, Colorado Division of Wildlife, Estes Park Rotary, Estes Valley Improvement Association, Estes Valley Land Trust, Estes Park Parks Department, Estes Park Recreation District, Estes Park School District, YMCA of the Rockies, and Boulder County Open Space contributed matching funds or supported costs of the program.

In 1998 about 1,500 acres of public and private lands were mapped and 100 acres were treated with herbicides. On 20 acres the weeds were mowed and pulled out by hand. About 95 acres were treated with biological control insects. All the leafy spurge inside Rocky Mountain National Park and all the diffuse knapweed inside the park and within $^{1}/_{2}$ mile outside of the park boundary were controlled.

Weir Farm National Historic Site and its neighboring private landowners in the towns of Ridgefield and Wilton, Connecticut, were invaded by nonnative plants. The park, which also received funds from the Pulling Together Initiative, spearheaded the formation of a team to control invasive plants throughout the local community. The team consists of two garden clubs, two town conservation commissions, an environmental education center, a watershed preservation organization, and the park itself. Its objectives are to inform the local community of the problem with invasive plants and to hold field days to demonstrate plant identification and weed-control techniques.

In 1998 several articles appeared in local papers and in magazines, a local radio station featured discussions, and a local cable channel periodically showed slides of various noxious weeds and offered advice for control. Several public lectures focused on identification of and control measures for invasive plants, and on alternative landscape plantings. Practical work sessions gave people experience in controlling invasive plants, such as Asiatic barberry, autumn olive, oriental bittersweet, winged euonymus, and multiflora rose. An invasive plant symposium, bringing together federal, state, and local interest groups, is planned for 1999.

EXOTIC SPECIES FACT BOOK PUBLISHED

In October, parks received the fact book Invasive Plants Changing the Landscape of America. *This reference summarizes the impacts of noxious weeds upon ecosystems of the United States and is intended for use by decision makers, resource managers, and others who need information about invasive plants. The book is published by the Federal Interagency Committee for the Management of Noxious and Exotic Weeds, which is cochaired by the National Park Service, and is available from the U.S. Government Printing Office (www.access.gpo.gov).*

AT WHAT COST? DECIDING WHETHER TO CONTROL EXOTIC PLANTS GPRA

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By accident or on purpose, many African plant species, particularly buffelgrass, have invaded the desert Southwest, where the climate is similar to that in parts of Africa. Ecologists in southern Arizona have been alarmed about the invasion and have called it the "Africanization" of the Sonoran Desert.

Buffelgrass is a 1- to 4-foot-tall, drought-tolerant perennial bunchgrass with many stems arising from a base. It is fire-tolerant and can colonize disturbed and undisturbed sites. In Organ Pipe Cactus National Monument in Arizona, buffelgrass was first recorded in 1984. Its abundance increased rapidly. By the late 1980s, the grass had colonized more small areas, and by the mid-1990s the native vegetation along the southern boundary of the monument was being replaced by monotypic stands of buffelgrass. The prospect of losing an important piece of the most biologically diverse North American desert seemed imminent. The dismal thought of buffelgrass replacing the organ pipe cactus, with its sweet nectar and fruit; the giant saguaro, with its distinctive shape; and the ironwood tree, with its life-giving shade; spurred action by park resource managers.

Many plant ecologists were against mechanical removal because they feared disturbance of the soil would favor the species, not eradicate it. Despite those concerns, the staff at Organ Pipe Cactus National Monument tried to mechanically remove the buffelgrass from a small test area. The next year, some seedlings were removed from the same area. Since then the area has been free of buffelgrass.

Impetus for further action came from consulting the NPS Natural Resources Report *Handbook for Ranking Exotic Plants for Management and Control.*[1] This publication outlines an analytical approach (modified for our purposes) to prioritizing management actions by considering the significance of impacts from an exotic species and the feasibility of control. In view of the potential for ecosystem-wide effects and the success in the test area, the scope of the project was broadened during 1998. In just several months, about 40 tons of buffelgrass were removed from thousands of acres. By the end of winter 1998–99, about 41,472 hectares, or 10,240 acres (95%), of the formerly infested area was free of buffelgrass.

A classic Sonoran Desert park, *Organ Pipe Cactus National Monument faced the potential loss of biodiversity from a progressive invasion of nonnative buffelgrass. After carefully considering the ecological consequences of the infestation, staff removed 40 tons of the species from over 10,000 acres. A program is now in place to monitor effectiveness of the removal.*

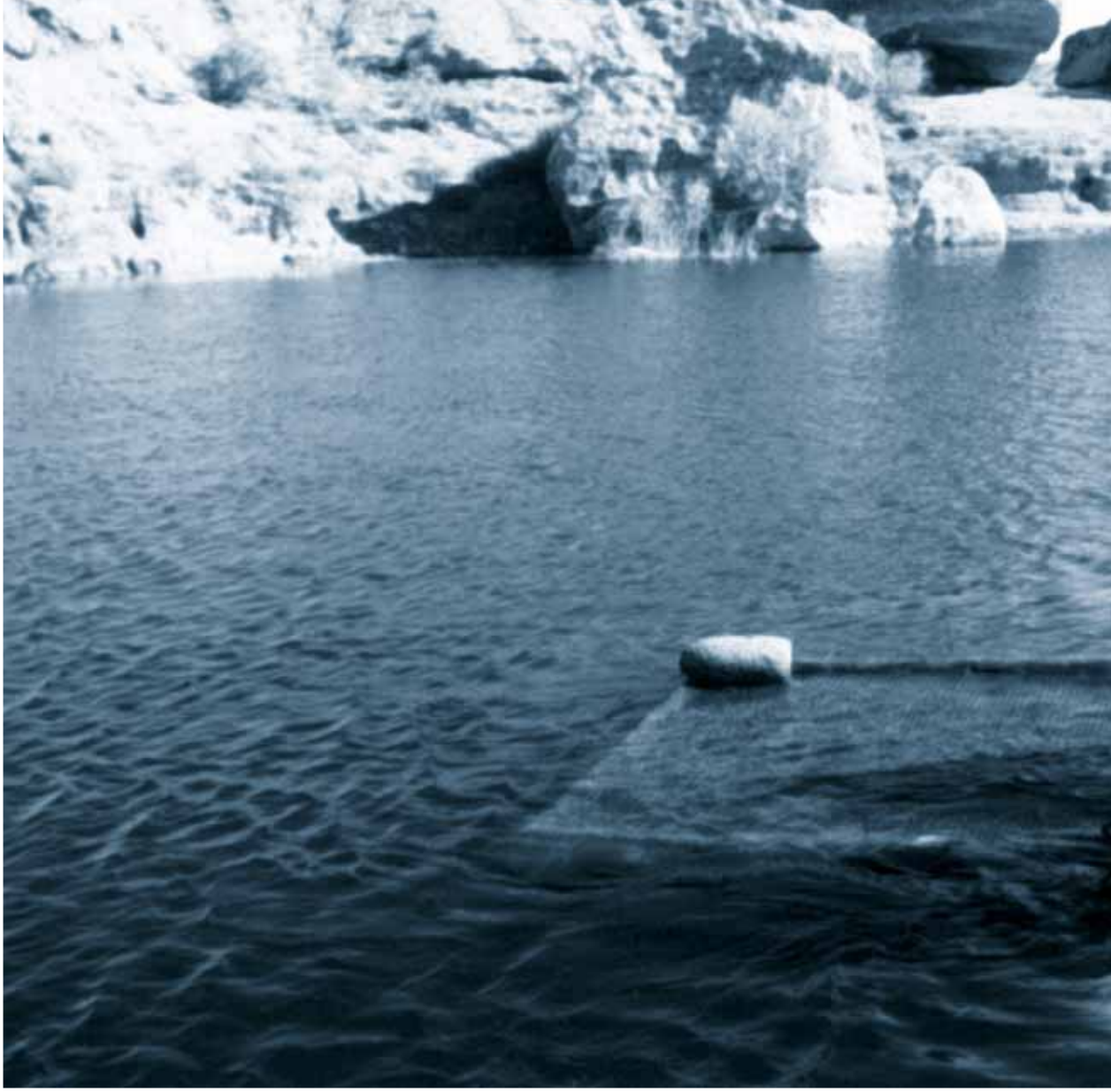
For monitoring the effectiveness of the removal, plots were established and inspected every three months during the first year. Early results suggested that mechanical removal was effective if seedlings were removed the following year. Few new plants have established themselves in most plots. Reestablishment of plants was primarily a problem only in sites where wildland fires had occurred accidentally.

Control of buffelgrass will require continued vigilance and removal; however, this effort seems worthwhile. Time spent removing the grass—accomplished by part-time staff and volunteers—was roughly the same as or less than that spent picking up refuse along the single highway through the monument. With an ecosystem at stake, this time is a small cost.

[1]Hiebert, R. D., and J. Stubbendieck. 1993. *Handbook for Ranking Exotic Plants for Management and Control.* Natural Resources Report NPS/NRMWRO/NRR93/08. National Park Service, Denver, Colorado.

LAKE MEAD SWAT TEAM

The exotic plant SWAT team headquartered at Lake Mead National Recreation Area (Nevada and Arizona) and funded through FY 1999 was busy in 1998 treating six nonnative species in nine units of the national park system in the Southwest. The crew of 10 spent nearly 3,600 hours treating or following up on earlier treatments of tamarisk, Russian olive, ailanthus, pampas grass, oleander, and date palm at the parks. This regional approach to exotic species control is proving efficient and effective and may be used elsewhere in the national park system.



Researchers retrieve carp *from Lake Mead in preparation for a follow-up study on the effects of the endocrine-disrupting chemicals on park fish populations.*

NEW PROBLEM FOR YELLOWSTONE CUTTHROAT

Caused by a microscopic parasite of European origin, whirling disease was found in 11 of 41 Yellowstone Lake cutthroat trout sampled during the fall. The disease attacks the cartilage of some fish species, causing whirling behavior and often death either from the disease itself, starvation because of inability to feed normally, or increased vulnerability to predators such as the non-native lake trout, which were first confirmed in Yellowstone Lake in 1994. Park biologists do not know what effect the disease will have on the native cutthroat population. Indeed, many questions remain unanswered, such as why some fish are more susceptible than others, what role alternate hosts play in disease transmission, and how the disease can be controlled.

External Development

SOURCE OF CHEMICALS THAT FEMINIZE LAKE MEAD FISH DISCOVERED

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Researchers from the U.S. Geological Survey have found high levels of the female hormone vitellogenin in male carp in Lake Mead (Nevada and Arizona). Normally, only female carp produce vitellogenin, a compound that promotes egg-laying. The presence of this chemical in male carp indicates that something, possibly a pollutant, has "feminized" the males. Since certain synthetic chemicals can mimic or block the activity of natural hormones, causing significant impacts on fish, wildlife, or humans, Lake Mead National Recreation Area staff took action to determine the source of the problem.

The Water Resources Division assisted Lake Mead National Recreation Area staff in contacting experts from around the world to help decide how to handle this problem. An advisory group of these experts was convened to develop strategies for identifying the chemical(s) responsible for the endocrine impacts on the carp's normal hormonal functioning. At the group's urging, Shane Snyder, an environmental toxicologist and chemist at Michigan State University, began a study to identify the chemical compounds responsible for the endocrine disruption.

The study results, published in 1998, suggest that natural and synthetic hormones originating in women's urine are among the culprits. Human female reproductive hormones,

including estradiol (natural estrogen) and ethinyl estradiol (the synthetic hormone in the birth control pill), were identified as the initial prime suspects in endocrine disruption of Lake Mead fish. Ethinyl estradiol is much more resistant to breakdown in the environment and in current wastewater treatment systems than are natural estrogens. Other potentially endocrine-active synthetic chemicals in Las Vegas Wash, the site of the study, include butyl tins and perchlorate.

Initial discussions were held with operators of the Las Vegas wastewater treatment plants to determine if remedies are available to remove the estradiol and ethinyl estradiol compounds from treated discharges. However, this treatment process will be difficult and expensive. Instead of focusing on the sewage treatment option, the Park Service will concentrate on more completely documenting the effects of these chemicals in the water column on fish and fish populations. With this goal in mind, the Southern Nevada Water Authority and the National Park Service are supporting a study of the effects of the chemicals on caged fish. In addition, endangered fish studies are being considered; if endangered fish are at risk, managing the level of the disruptive chemicals becomes even more important.

The suspect chemicals (estradiols, organochlorines, and phenols) are changed by the human body into a less estrogenic and more water-soluble form that can move around easily in surface water. Once these chemicals are transported to other media (such as sediments, fish guts, or human guts), they may be changed by bacteria back into the more estrogenic form, which is more hazardous, more endocrine-active, and less soluble (less mobile) than the parent compounds.

As the city of Las Vegas continues to grow rapidly, and as the flow of treated sewage into Lake Mead increases, endocrine disruption and other impacts on water quality and park resources may also grow and will need to be closely monitored and mitigated.

Award-Winner Profile
KENT TURNER HONORED

The 1997 Director's Award for Natural Resource Management was given to Kent Turner, chief of resource management at Lake Mead National Recreation Area (Nevada and Arizona). An effective administrator, Kent has developed a professional and respected resource management staff. Through their efforts, park natural and cultural resources are now widely recognized as both important and varied. Under his guidance, Kent's staff devised and implemented monitoring strategies for the relict leopard frog, desert tortoise, and desert shrub plant communities. Seventy percent of the park boundary is now protected through partnerships with adjacent land managers. A burro management plan is complete and more than 900 burros have been removed from the park. Nineteen springs and eight other sites are free of non-native tamarisk, and a native plant nursery has been established. This robust resource management program, assembled and nurtured through Kent's energies and support, has strengthened partnerships with park neighbors and improved the information upon which management decisions are made.

Natural Resource Program Center

Kent Turner

PROTECTING THE NATURAL "SOUNDSCAPE" IN PARKS

by William B. Schmidt

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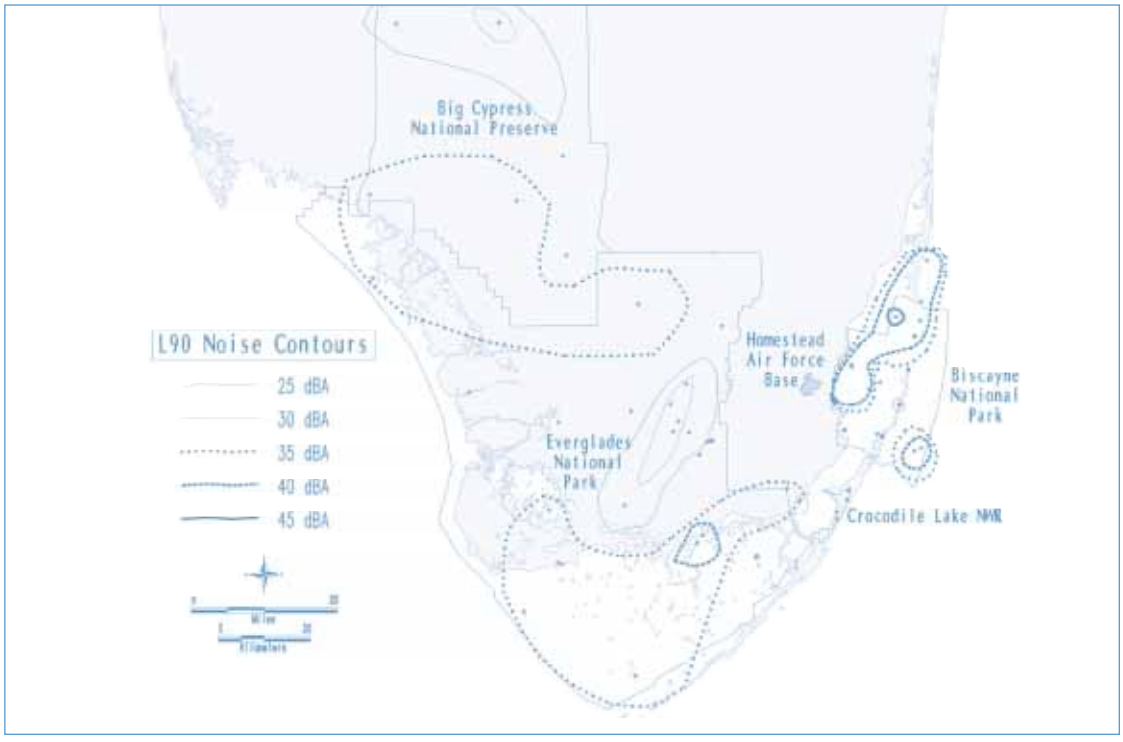
"There are many places in the national park [system] which look very much as they did 200 years ago but very few places which sound like they did even 20 years ago."

—Chip Dennerlein, Alaska Regional Director
National Parks and Conservation Association

The National Park Service is moving to define and resolve a set of problems involved in protecting and restoring an overlooked and often abused resource: the soundscape. One aspect of the noise pollution issue in parks, air tour overflights, has been a focus of the National Park Service since 1975. However, the deterioration of the soundscape due to all sources of human-caused noise is just starting to be addressed. One cluster of parks—Biscayne, Everglades, and Dry Tortugas National Parks, and Big Cypress National Preserve in south Florida—may point the way to the future of noise management in the national park system through the lessons learned and the techniques developed in those parks.

For the past few years, these parks have been the subject of noise monitoring and analysis. Initially, the catalyst was a supplemental environmental impact analysis led by the Air Force and the Federal Aviation Administration (FAA) and related to the proposal to convert the former Homestead Air Force Base, devastated by Hurricane Andrew in 1992, into a major single-runway, civilian airport. The issue has evolved into one of soundscape protection as the parks came to recognize that all human-caused noise was the problem, not just noise from aircraft.

Monitoring began in 1997 when the National Park Service sent a contractor into the field to collect the first scientific information on the nature and magnitude of natural sounds and some of the sources of human-caused noise intrusions in Everglades and Biscayne. Shortly thereafter the Federal Aviation Administration collected



The L90 noise contour map *depicts background noise levels in A-weighted decibels, minimizing the effects of human-caused sounds, in three south Florida parks. Points on the same contour line have the same value and are based on noise monitoring and analysis work, which began in 1997. The map represents a first attempt to define the natural soundscape in these parks.*

data in the area using a different method. Unfortunately, both methods have faults. The FAA approach, in particular, was keyed principally to the collection of data on aircraft noise, not on the levels of quiet the National Park Service seeks to protect. Another complication was trying to extrapolate noise data from the collection points to broader areas for the purpose of defining a park's soundscape.

In November the NPS contractor went back into the field. This time, in addition to conducting hour-long monitoring at six sites missed by the Federal Aviation Administration, the contractor set up unattended monitoring stations to collect data on diurnal variations in noise level. These data, coupled with the previous data, have begun to provide some answers.

A combination of unattended monitoring and targeted monitoring to establish daily and seasonal noise variations, and to identify the nature and levels of intrusive noise, is proving to be a better sampling strategy. The National Park Service is drafting a manual describing this method and, in 1999, plans to define a credible process for describing a park's soundscape based on disparate data. Additionally, a statistic called "L90," the sound level exceeded 90% of the time, is a useful estimate of the natural soundscape, particularly under relatively noisy conditions. A policy is being drafted that spells out obligations of the National Park Service to inventory, monitor, and protect the soundscape. Many concepts related to soundscape preservation are already discussed in the NPS education package "The Nature of Sound," and a forthcoming NPS director's order will provide further direction on this issue. Finally, Biscayne, Everglades, and Big Cypress are in various stages of developing noise management plans that detail what can and must be done to protect their soundscape resources.

MELALEUCA CONTROL CONTINUES

Big Cypress National Preserve (Florida) continues to succeed in its partnership with Dade County and the Florida Department of Corrections for the control of melaleuca. At a cost of $220,000 in 1998, the partners re-treated 701,736 seedlings and resprouts of the nonnative tree species on 35 square miles of infested lands treated initially in 1997. The preserve also found matching funds from the Miami–Dade County Wetland Trust Funds for initial melaleuca treatments through FY 1999. A private contractor is available to the preserve and to Everglades National Park for five years to carry out the control effort.

© Jeff Selleck

Companion to this sawgrass prairie landscape *in Everglades National Park are the sounds emanating from wind, water, wildlife, and the many other natural wonders and ecological processes preserved in the park. Recent noise monitoring in the four south Florida parks is aimed at determining the natural soundscape in these parks and protecting it from the intrusions of human-caused noise.*